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NUCLEAR EXPLOSIONS IN SPACE

REPORT

OF THE

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LETTER OF TRANSMITTAL

HOUSE OF REPRESENTATIVES,
COMMITTEE ON SCIENCE AND ASTRONAUTICS,
Washington, D.C., June 5, 1959.

Hon. OVERTON BROOKS,
Chairman, Committee on Science and Astronautics.

DEAR MR. CHAIRMAN: I am forwarding herewith for committee consideration a report on "Nuclear Explosions in Space" prepared by Dr. Charles S. Sheldon II, technical director of the committee and reviewed by the other members of the professional staff.

This report is based on an executive hearing of the committee which has in large part since been declassified, and only those parts which the Department of Defense reported to us to be free from classified security information have been used in drafting the report. The witnesses were Dr. Herbert F. York, Director of Defense Research and Engineering, and Dr. Frank Shelton, Technical Director of the Armed Forces Special Weapons Project.

The report summarizes the nonclassified parts of the testimony, and incorporates some general committee views on this important subject.

CHARLES F. DUCANDER,
Executive Director and Chief Counsel.

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NUCLEAR EXPLOSIONS IN SPACE

INTRODUCTION

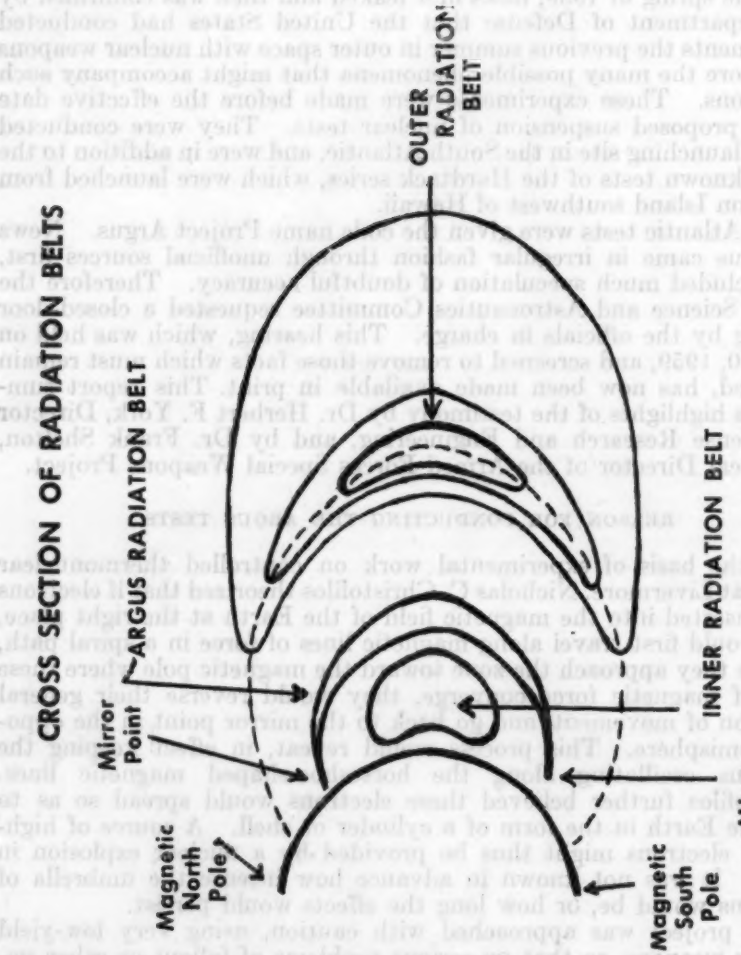
In the spring of 1959, news first leaked and then was confirmed by the Department of Defense that the United States had conducted experiments the previous summer in outer space with nuclear weapons to explore the many possible phenomena that might accompany such explosions. These experiments were made before the effective date of the proposed suspension of nuclear tests. They were conducted from a launching site in the South Atlantic, and were in addition to the better known tests of the Hardtack series, which were launched from Johnston Island southwest of Hawaii.

The Atlantic tests were given the code name Project Argus. News of Argus came in irregular fashion through unofficial sources first, and included much speculation of doubtful accuracy. Therefore the House Science and Astronautics Committee requested a closed-door briefing by the officials in charge. This hearing, which was held on April 10, 1959, and screened to remove those facts which must remain classified, has now been made available in print. This report summarizes highlights of the testimony by Dr. Herbert F. York, Director of Defense Research and Engineering, and by Dr. Frank Shelton, Technical Director of the Armed Forces Special Weapons Project.

REASON FOR CONDUCTING THE ARGUS TESTS

On the basis of experimental work on controlled thermonuclear power at Livermore, Nicholas C. Christofilos theorized that if electrons were inserted into the magnetic field of the Earth at the right place, they would first travel along magnetic lines of force in a spiral path, then as they approach the zone toward the magnetic pole where these lines of magnetic force converge, they would reverse their general direction of movement, and go back to the mirror point in the opposite hemisphere. This process would repeat, in effect keeping the electrons oscillating along the horseshoe-shaped magnetic lines. Christofilos further believed these electrons would spread so as to ring the Earth in the form of a cylinder or shell. A source of high-energy electrons might thus be provided by a nuclear explosion in space. It was not known in advance how intense the umbrella of electrons would be, or how long the effects would persist.

The project was approached with caution, using very low-yield nuclear weapons, so that no serious problems of fallout or other unexpected results might follow. On the one hand, the experiment represented pure science on a grand scale, potentially capable of contributing much fundamental knowledge on geophysics, force fields, radiant energy, and particle behavior. On the other hand, there was the possibility that the experiment might have considerable military significance. The electrons in the shell could conceivably become a radiation hazard to future manned satellites in orbit around the Earth. They might also have profound effects on the use of radio communications.


CROSS SECTION OF RADIATION BELTS
OUTER RADIATION BELT
ARGUS RADIATION BELT
INNER RADIATION BELT
Mirror Point
Mirror Point
Magnetic North Pole
Magnetic South Pole

CHOICE OF A LOCATION FOR CONDUCTING THE TESTS

The latitude chosen had to be fairly close to 45°. To pick a site much closer to the Equator would create such a shallow shell with mirror points so close together that the effect probably would not last long enough to provide much significant data. To pick a very high latitude would be to lose the mirror effect because the magnetic lines are not closed noticeably, and there is no trapping.

The reason for choosing the Atlantic rather than the Pacific for the experiment is that the Earth's magnetic field is not located at the geographical center of the Earth, but is offset about 200 miles. Electrons inserted on the Atlantic side of the Earth would be trapped about 700 miles above the Earth. On the Pacific side, with similar insertion, the path of travel to the mirror point for turnaround of the electrons instead of being in the near vacuum of space, would take place below sea level, and this would not create the right conditions for oscillation. Therefore the experiment had to be conducted on the Atlantic side of the world, and preferably at a place where both mirror points would be over international waters.

Because of greater traffic, the North Atlantic would have been an awkward place to launch nuclear weapons. Therefore, the relatively untraveled waters of the South Atlantic were used, with other ships and aircraft assigned to the North Atlantic to observe mirror effects. The ships sent to the South Atlantic had to travel a great distance from normal bases, and to overcome difficult launching conditions on stormy seas.

HOW THE EXPERIMENT WAS CARRIED OUT

The seaplane tender *Norton Sound* with accompanying ships traveled to the South Atlantic. The exact latitudes and longitudes have not been announced. Three X–17 rocket-launching vehicles were used, and three small nuclear weapons were exploded: on August 27, August 30, and September 6, 1958. The altitude of the explosions and the exact yield of the weapons have not been announced.

In order to monitor the results, instruments had been placed in Explorer IV (already in orbit), capable of distinguishing between the natural radiation of the Van Allen belt and the radiation caused by the nuclear blast. Explorer IV had been launched northeast from Cape Canaveral so that it would cover the zone of interest to the Argus experiment, including more northerly and more southerly latitudes.

Some 21 Argo solid-fuel sounding rockets, under the code name Project Jason, were fired with instruments from Wallops Island, Cape Canaveral, and Ramey Air Force Base in Puerto Rico.

Ships were waiting at sea in the general vicinity of the Azores near the mirror point to observe the artificial aurora created there.

OBSERVED TEST RESULTS

Some of the electrons inserted into the magnetic field were not trapped, but plunged into the atmosphere, creating a temporary aurora at the two mirror points for an hour or so. This aurora was visible as colored light to anyone who might have been looking for

it at the right place. It had the effect of interfering with local radio communications, but not on a worldwide basis.

Those electrons which were trapped showed up at the mirror point in peak intensity about a minute after the nuclear explosion. They were created in connection with the decay of fission products, and traveled at close to the speed of light, but along a corkscrew path, so that there was a slight delay in their arrival at the mirror point. In an hour or so, these electrons spread to form the world-encircling shell. The effects persisted quite noticeably for a week or more, with some traces left even after a few months. The shell had a thickness of about 100 miles when 800 miles up, but its thickness depended upon the altitude. At 4,000 miles from the Earth it may have been 1,000 miles thick. In general, the shell was located between the inner and outer Van Allen natural radiation belts, which made it easier to detect than if it had been at the same altitudes as either of the Van Allen belts.

MILITARY SIGNIFICANCE OF THE ARGUS EXPERIMENT

Certain aspects of the Argus experiment remain classified, and are not discussed in this report.

A nuclear explosion in space represents a way to interfere with local communications at the mirror point through the creation of an artificial aurora. Thus a weapon exploded near Tierra del Fuego would have the consequences of a natural magnetic storm in the New York area, or one exploded in the right point in the Indian Ocean could blanket Moscow. Whether this is practical in a military sense is another matter, and must be compared with the possibilities of similar explosions placed on targets rather than at mirror points.

A very large detonation, in contrast to the small test devices, might have a more widespread effect on communications. Rumors of worldwide effects from the Argus tests were inaccurate, misinterpreting some effects of the Hardtack thermonuclear tests in the Pacific.

The tests supplied some data on the injection efficiency of electrons derived from a nuclear explosion.

The tests did not prove that manmade radiation in space would necessarily interfere with manned space vehicles, as the vehicles could fly at different altitudes from those where artificially induced electrons would be trapped.

Dr. York also indicated that the Argus experiment was not a factor one way or the other in his general assessment of the anti-ICBM problem.

SCIENTIFIC SIGNIFICANCE OF THE ARGUS EXPERIMENT

Most of the information about the Argus experiments is being made available to the scientific community on an unclassified basis. The only things being held back with regard to the explosions are the exact yields, the exact times, the exact altitudes, and the exact locations of the launchings. In the opinion of the Department of Defense, this withholding will not do scientific harm, and it will protect certain military information, such as how to identify nuclear explosions in space from among the mass of other data and "noise" showing on instruments.

Argus was conceived before the discovery of the Van Allen radiation belts. It was an experiment on a grand scale, and helped to throw light on a number of natural processes. Undoubtedly, scientists will develop many hypotheses of value as the analysis of the data continues. These relate to the magnetic field, auroras, radio propagation, nuclear-explosion effects, radiation fields, and a better understanding of controlling thermonuclear processes.

THE SECURITY BREACH IN PROJECT ARGUS

Somehow, the New York Times learned of Project Argus at a very early stage, in advance of the tests. If the Times had published the information then, or if the information had reached certain foreign governments, it is quite likely that it would not have been possible to proceed with the tests, even though the information could have been of great military value.

As time passed, the Times demonstrated privately to officials that it was familiar with most of the major parameters of the project, and further became convinced that these would not remain classified much longer because of small leaks from other sources. So in March 1959 the story was published. The Department of Defense then made its own announcements on Project Argus.

The Department of Defense had spent many months following the tests assessing the data, and planned at an appropriate time to release as much of the information about the tests as it could, using the medium of the National Academy of Sciences. Only a few weeks separated the New York Times story and the completion of major preliminary analysis by the Department of Defense.

In testimony before this committee, the representatives of the Department deplored the leak, but also noted how close security had come to being successful. They acknowledged that the leak had been potentially very dangerous.

CONCLUSIONS

Project Argus is symbolic of the stirring times in which we live On the one hand, it was a boldly conceived experiment in pure science of immense geophysical proportions, labeled by some publicists as the greatest scientific experiment in all history. On the other hand, it had to be conducted as a secret military operation because it involved a host of questions which might affect the balance of military power in the new technologies of missiles and space travel.

In a sense the results were mostly scientific, and the military results were somewhat negative. There has been no announcement that any really compelling military consequences can be foreseen from the experiments that in any way live up to public speculation about nuclear weapons in space. Laymen have wondered whether nuclear weapons in space would create a shell of sufficient intensity as to make manned satellites impractical. They have also wondered whether the intensity of such radiation could in any way create an umbrella of protection against incoming ICBM's, or whether the nuclear warheads of such missiles would be "cooked" to explode prematurely. They have wondered whether radar would be so interfered with as to change the antimissile defense outlook. But the only positive potential military

effect which has been acknowledged by the experts relates to local interference with communications through the creation of artificial auroras.

On the other hand, further drama surrounds the Argus test because of its close link with the broader question of international control of nuclear testing, and the possibilities of detecting such tests wherever they occur. Surface tests have been thought the easiest to detect. Underground blasts are believed by some to be always traceable, and by others to afford a degree of privacy. Now the question of detection of tests in outer space is presented.

Is there a case for continuing experiments with nuclear weapons outside the Earth's atmosphere? What fallout problems, if any, are presented? What international concern should be shown for any proposal to explode a nuclear weapon on the Moon as a way of signaling arrival of a rocket and also as a means for testing the surface, and possibly for catching debris with an orbiting manmade satellite of the Moon for return to Earth? What of recent proposals for firing a thermonuclear weapon many millions of miles away from the Earth as a way of testing the validity of some accepted theories of relativity? What should be done about new proposals to lift a space station weighing thousands of tons through a series of nuclear explosions? What tests should be considered military, and what scientific? What are the places of unilateral national action in such tests, and where must international cooperation be the rule?

Argus has perhaps raised as many questions as it has answered. It is likely not the last word which will be spoken in the area of imaginative experiments on the grand scale. With the rapid improvements expected in man's space capabilities, nuclear energy is certain to play an important part.

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